REMARKS/ARGUMENTS

Claims 1-11, 24 and 35 are active.

Claim 1 is:

> A fuel cell system comprising:
> a fuel tank storing a fuel comprising dimethyl ether, water, 5-10 wt% of methanol, the mixing ratio of dimethyl ether and water is in a range of 1:3 to 1:4;
> a vaporizer configured to vaporize the fuel;
> a reformer configured to reform the vaporized fuel into a hydrogen rich gas;
> a CO gas removal apparatus configured to remove CO gas in the hydrogen rich gas; and
> a fuel cell unit configured to generate electricity by electrochemical reaction of the hydrogen rich gas and oxygen.

Applicants thank the Examiner for the courtesy of meeting the Applicants undersigned representative on September 11, 2008 to discuss the rejections and some additional data, which is now presented in the attached Rule 132 Declaration.

During this meeting, the undersigned emphasized again that the prior art does not not provide any suggestion for the claimed fuel components in the ratios defined in a fuel cell also including a reformer and indeed provide no indication as to how DME contributes to the reforming reaction in the fuel cell. That the art does not provide the requisite disclosure that would lead one to the claimed invention, the claims cannot be considered obvious. Further, there is nothing in what has been cited in the rejection that minimizes or contradicts the Applicants surprising findings for the claimed fuel, in the claimed mixing ratio, in the type of fuel cell being claimed.

The discussion then turned to some new data that is submitted in the attached Rule 132 Declaration. The data demonstrate that the concentration of methanol at 5-10 wt% is better than methanol concentrations less than 5wt% and greater than 10% by experiment and calculation.

(1) About methanol concentrations less than 5wt%

(a) In the experiment, DME (46.4mL) and water (15mL) were mixed. Consequently, DME (37.8mL) and mixed solution of H20/ DME (20mL) were obtained. In a DME-H_2O system (MeOH-free system), 0.150mol of DME only dissolved in 1mol of water. However, the obtained matter was not suitable for the fuel for the claimed fuel system because the obtained matter immediately separated into two phases (liquid/gas phases).

(b) DME (22mL) and water (22ml) including methanol of 5wt% were mixed. Consequently, H_2O/ DME mixed solution that is in a liquid phase (and homogenous phase) was obtained. In such a case, 0.240 mol of DME dissolved into 1mol of water. The fuel ratio of DME: H_2O was 1: 4.15. Thus, the fuel ratio of DME: H_2O > 1: 4 was achieved. It is also confirmed that all DME (22mL) was stably dissolved in water.

See Declaration paragraph (7)

(2) About methanol concentrations greater than 10wt%

As described above, if methanol is added into DME/water solution, the dissolubility to H_2O of DME is improved.

However, if methanol is added greater than 10wt%, the energy density for each unit area of the fuel is decreased.

Table 1 shows the mutual solubility of DME and water in a case that DME (22mL) and solution (22ml) of methanol and H_2O were mixed. In Table 1, the concentration of methanol was changed to 5%, 10%, and 20%.

Table 1 DME-H_2 Mutual solubility test

No	MeOH	H2O	DME	MeOH水溶液の比重	mL-DME/g-H2O	g-DME/g-H2O	mol-DME/mol-H2O	mol-H2O/mol-DME
	wt%	wt%	mL	g/mL	—	—	—	—
1	5	95	22	0.98	0.92	0.617	0.242	4.140
2	10	90	22	0.97	1.15	0.766	0.300	3.338
3	20	80	22	0.95	1.32	0.879	0.344	2.906

"MeOH 水溶液の比重" = specific gravity of MeOH solution

In a reform type fuel cell system such as claimed fuel system, in a stoichiometric chemical reaction, 1 mol of DME reacts with 3 mol of water and 6 mol of hydrogen is generated.

$$CH_3OCH_3 + H_2O \rightarrow 2CH_3OH$$
$$2CH_3OH + 2H_2O \rightarrow 6H_2 + 2CO_2$$
$$CH_3OCH_3 + 3H_2O \rightarrow 6H_2 + 2CO_2$$

According to the Table 1, if 20 wt% of methanol is added, the amount of H_2O/ DME (mol/ mol) is less than 3mol (2.906mol). As it is understood from the equations, the amount of H_2O is stoichiometrically insufficient. 0.1 mol of water may be further added to the fuel tank. However, the volume of the fuel is increased. Accordingly, energy density for each unit area of the fuel is decreased.

Therefore, it is necessary to have the fuel comprising dimethyl ether, water, and 5-10 wt% of methanol, the mixing ratio of dimethyl ether and water is in a range of 1: 3 to 1: 4, to achieve stably generated electricity in a claimed system.

See Declaration paragraph (7)

It should be now understood from the data above that the concentrations of methanol below 5% yielded a two-phase composition. While Pan describes a range of 2-5% touching on the claimed lower value of methanol in the claims, this concentration would while operable in Okamoto's fuel cell system would make Okamoto's system inefficient and impractical. ***See Declaration paragraph (8***

As shown in paragraph [0006] of Pan, Pan considers a DMFC system and describes that 92.5% of water becomes "dead weight" because one water molecule is consumed with each methanol molecule in the electrochemical reaction. ***See Declaration paragraph (9)***

When Pan's fuel is supplied to Okamoto's reformer, only 5wt% of methanol would be reformed and hydrogen generated by the methanol (92.5 wt% of water is exhausted). In such a case, the hydrogen generated in Okamoto's reformer would be too small to generate

electricity because Pan's fuel only includes 3-5% of methanol. Therefore, Pan's fuel would not be operable in Okamoto's fuel cell in practice. The can be said about Muller's applicability in Okamoto's fuel cell as well. ***See Declaration paragraph (10***

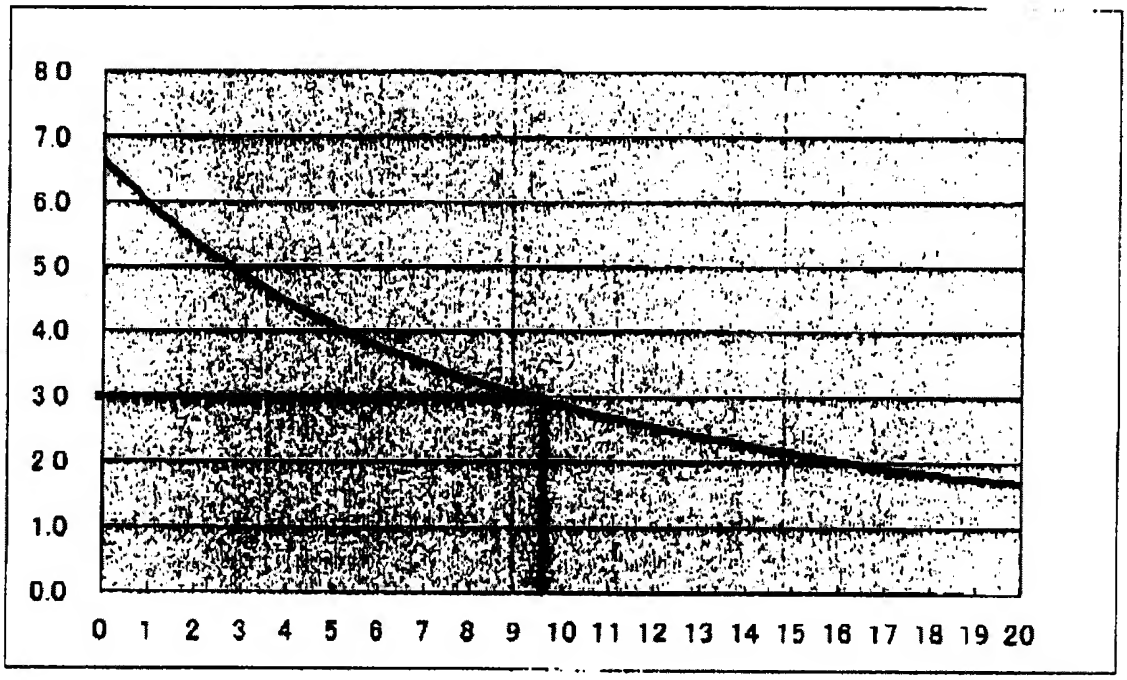
In contrast, the claimed fuel which uses DME and methanol for generating hydrogen generates about 67-77 mol% of hydrogen. Thus, the amount of generated fuel is completely different. ***See Declaration paragraph (11)***

Therefore, the combination of Pan, Muller, and Okamoto do not describe the claimed fuel cell, including fuel nor the effectiveness of what is achieved by that fuel cell and fuel. ***See Declaration paragraph (12)***

With respect to the concentrations greater than 10%, while the comparison of methanol for the comparison was two-times the amount of the claimed range and the lower point of comparison in Table 1 of 10%, this comparison is relevant and shows the advantages of the claimed fuel cell system and fuel contained in that system. ***See Declaration paragraph (13)***

Further, in a reformed type fuel cell system, it is important that the stoichiometric mixture ratio of DME/water is kept over 3. This is because if the stoichiometric mixture ratio is less than 3, a large amount of carbon monoxide is generated because of the lack of water. As a result, the carbon monoxide poisons the catalyst in the fuel cell thereby decreasing the power generating efficiency in the system. ***See Declaration paragraph (14)***

The following graph shows stimulation data demonstrating the relationship between the methanol concentration [wt%] and the mole ratio of DME/water [-].



See Declaration paragraph (15)

If the concentration of the methanol is about 9.6 wt % (about 10wt%), the stoichiometric mixture ratio of DME/water will be over 3. In such a condition, the fuel cell system is stably operated and/or higher power generation efficiency would obtained. ***See Declaration paragraph (16)***

On the other hand, when the concentration of the methanol is about 11-12 wt%, the stoichiometric mixture ratio of DME/water is less than 3. This will result in carbon monoxide that will poison the catalyst and/or decrease the power output. ***See Declaration paragraph (17)***

As the solubility of DME to water may be changed by the conditions, the fuel having DME, water and 5-10 % methanol with a mixing ratio of DME and water in the range of 1:3 to 1:4 has been determined to achieve stably generated electricity. As this is not at all described or suggested by Pan, Okamoto, and Muller, it could not have been reasonably expected that this particular range of methanol and mixing ratio of DME and water would

work as well as it did, which has been shown by the data presented in the application and in the Declaration. ***See Declaration paragraph (18)***

Thus, the claims would not have been obvious as the combination defined in the claims yields **more** than "a predictable result." (see *KSR Intern. Co. v. Teleflex, Inc.*, 127 S.Ct. 1727 (2007)).

According to the present invention, DME and water are not separated into two phases in the claimed tank, and a desirable stoichiometric composition of fuel can be obtained. As the fuel in the claimed fuel cell is not separated into two phases in the tank, the fuel with the defined stoichiometric composition is stably supplied to the vaporizer, reformer, and CO gas removal apparatus, and fuel cell unit. Thus, the electricity is stably generated in the applicant's fuel cell system. That this could be achieved is considered by the inventors to not have been expected based on what was known.

What is defined in Claim 1 is not the discovery of optimum working conditions for the fuel cell as alleged in the rejection. Rather, the fuel ratio (claimed fuel comprising dimethyl ether, water, and 5-10 wt% of methanol, the mixing ratio of dimethyl ether and water is in a range of 1: 3 to 1: 4) is one of the important features for the present invention to achieve stably generated electricity.

As Okamoto, Muller et al. and Pan et al. fail to disclose or suggest the fuel cell defined in Claim 1 and the unexpected advantages obtained thereby, the claims would not have been obvious in view of these citations. Withdrawal of the rejection is requested.

The rejections of Claims 7 and 8 under 35 USC 103(a) in view of Okamoto, Muller, and Yonestu; based on the combination of Okamoto, Muller, and Suzki for Claim 9; or Okamoto, Muller and Kaneko for Claim 10 are also not applicable to the claims. These rejection differs from the Okamoto, Muller, and Pan rejection primarily for the reliance on

(A) Yonetsu for the particular features of the fuel tank defined in claims 7 and 8; (B) the added features in Claim 9; and (C) reforming catalyst from Kaneko.

However, for the reasons similar to those detailed above, this combination of art does not provide any suggestion for the claimed fuel components in the ratios defined in a fuel cell also including a reformer and indeed provide no indication as to how DME contributes to the reforming reaction in the fuel cell. That the art does not provide the requisite disclosure that would lead one to the claimed invention, the claims cannot be considered obvious. Further, there is nothing in what has been cited in the rejection that minimizes or contradicts the Applicants surprising findings for the claimed fuel, in the claimed mixing ratio, in the type of fuel cell being claimed.

Withdrawal of these rejections is requested.

A Notice of Allowance for all pending claims is requested.

Respectfully submitted,

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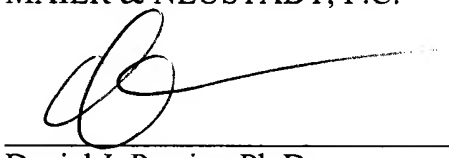

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